

INTERIM PROGRESS REPORT

Submitted to the

NOAA Human Dimensions of Global Change Research (HDGCR) Program

July 22, 2005

Project Title: “Use of Climate-Information Products by Water Managers and Other Stakeholders in Two GCIP/GAPP Watersheds in Arizona/Sonora and Oklahoma”

[Note that Oklahoma portion of this grant was awarded under a separate contract to USDA/ARS; the foregoing report pertains only to work undertaken by the University of Arizona team.]

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I. Preliminary Materials *[Note that Section I refers to and is drawn from the original proposal.]*

A. Project abstract

Building upon previous research and outreach efforts in the San Pedro Basin (Arizona/Sonora) and Washita/Red-Arkansas Basin (Oklahoma), we proposed a three-year project to continue and expand our efforts to 1) assess climate information products/tools for water management, 2) find ways to narrow the communication gap between climate experts and information users, and 3) improve ways to integrate the science of climate with public policy. The San Pedro basin has been designated, with the support of the GEWEX Water Resource Applications Project (WRAP), as a Demonstration Basin (the most advanced, and accordingly, most in tune with the principles and aims of HELP, of four categories) by the UNESCO-based, global HELP (Hydrology for the Environment, Life and Policy) Initiative. The proposed work is intended to expand the body of research related to the theoretical and practical aspects of the role of climate information for water management, stakeholder decisionmaking, and public policy, and build upon the contributions from regional climate impacts and vulnerability assessments, particularly those focused on water basins.

B. Objective of research project

Assess products and tools

- Assess status of available climate information useful in a transboundary (U.S.-Mexico) context
- Obtain evaluation of transboundary climate information from stakeholders
- Determine product usability, accuracy, and utility in interaction with natural-resource/water stakeholders/managers
- Identify potential opportunities to transfer NAME products into transboundary settings

Bridge communications gap

- Narrow knowledge and communications gaps between climate researchers/products and area stakeholders
- Identify areas where improvements in climate products could be made and provide feedback to climate scientists/forecasters

Integrate science and policy

- Assess the potential impacts of climate variability and change on water policy, economic development, and land management/land use practices
- Identify promising avenues for introducing science into policymaking
- Identify innovative ways to link stakeholders with forecasters and forecast models for the interface between land use, climate and hydrology
- Assess the potentials and constraints of using the watershed-council framework and water focus groups for integrating science and policy

C. Approach

Assess products and tools

- Using archival information and surveys, analyze trends in demographics, institutional changes, water management, economic growth, and land use/land tenure arrangements
- Using focus group and workshop techniques, assess need for/use of climate information

- Introduce stakeholders to climate forecasts and related information through structured workshop settings; use structured workshop interactions, as well as follow-up surveys, as needed, to obtain feedback on utility, usability, and perceived accuracy of the information provided
- Conduct structured analysis of results of focus groups, workshops, and surveys to assess climate perceptions and how these are linked with decisions/actions
- Using the DSS model developed by Kevin Lansey, develop an assessment of the sensitivity of water resources on Mexican side of border to climate variability (assuming sufficient data are available to conduct the analysis). Using the results of surveys and focus groups, assess the capacity of basin residents to design and implement adaptive management strategies that reduce/avert vulnerability to climatic stresses

Bridge communications gap

- Conduct preliminary focus groups to ascertain how participants define and view climate, identify the types of climate conditions that pose the greatest concern, as well as the greatest potential benefit to area residents and to identify current coping mechanisms
- Hold capacity-building workshops in the use and interpretation of climate information with watershed councils or climate and resource focus groups
- Establish a regional coordinator/facilitator in southwestern Oklahoma to promote the collaboration of federal and state water agencies, tribes and local landowners on regional water, climate, and land-use issues

Integrate science and policy

- Investigate land tenure, soil and water management in Mexican portion of the San Pedro for policy implications under conditions of climate variability and change
- Carry out a structured assessment of the results of the research conducted in this project to determine extent to which science is already integrated into policy structures and the potential for/barriers to introduction of climate information into such processes
- Identify changes that must be made in organizational, institutional, and professional frameworks in order to increase the integration of science into policy making and implementation processes, including enhanced participation of community members in scientific research as well as increased outreach from scientists to residents of the region

II. Deviations from Proposal

Rather than include this discussion within the Accomplishments section below—which would tend to obscure the modifications to the workplan—we are presenting this before the report on work done.

In the first annual progress report (June 2004), we highlighted the difficulty of assessing information on climate variability in real time. We also noted the cross-border disparity in availability of information and expertise. And, we indicated implicitly that on both sides of the border, for different reasons, attention to climate-related issues does not enjoy widespread priority among either decisionmakers or other stakeholders. These challenges persist and will not soon dissipate.

But over the past year, the project team has experienced a set of previously unfelt constraints. Beginning just before the end of the first project reporting period, a significant set of political developments occurred in the Mexican portion of the San Pedro basin. Notwithstanding the research team's longstanding and well-received presence, experience, collaborative relationships, and record of accomplishment in Sonora, larger forces came into play.

The project's aim to foster greater understanding and acceptance of integrating climate forecasting with water management, and to do this via community-based water councils was met with varying degrees of wariness. At the most local level, our efforts were supported by several community groups such as a then-incipient environmental NGO (nongovernmental organization), ARASA (Sonora-Arizona Regional Environmental Association) and by officials of the municipalities of Cananea and Naco. But historic differences of opinion surfaced between on the one hand, the strong Cananea-based mining interests and their state government supporters, and on the other hand environmental groups such as ARASA. Compounding this dynamic, regional officials of the Mexican national water commission (CNA) expressed concern that only officially-designated watershed councils (*consejos de cuenca*) were authorized to operate in the area (none has yet been so designated for the San Pedro). Additionally, the highly centralized CNA defines its priorities nationally, leaving small, lightly-populated basins such as the San Pedro poorly funded and without influential champions. Even at the regional level, the CNA in Sonora simply does not consider the San Pedro among its highest priorities, given its range of more pressing needs and demands from larger urban and major agricultural areas. Adding to the uncertainty, after more than a decade of increasing closeness between Mexico and the United States, the events of September 11 and its aftermath have resulted in distinctly cooler relations—a state of affairs that has palpably affected transborder cooperation. And finally, the situation is further complicated by the fact that a very significant presidential election is coming up in mid-2006. It is not clear what the new leadership will be, and how much of the reforms of President Vicente Fox and former President Ernesto Zedillo will be carried through by the new administration—in particular, in regard to water councils and formalized public participation.

In such a context, those aspects of the project that could be seen as going beyond mere research (as expressed in the opening sentence of the preceding paragraph) were interpreted by some as uninvited involvement in the affairs of another nation. The manifestations of this new attitude were mostly subtle and certainly not overtly hostile, but it became clear that our investigators could not easily attend official meetings, interview key personnel, or gain access to such relevant information as exists. This situation may have eased somewhat in recent months and we have perceived a shift toward more openness on the part of CNA and others to our research entrees. This leads us to believe that things are moving in a positive direction. Nevertheless, given the lifetime of the grant, we may not be able to capitalize on these improvements to the extent we would have a year earlier.

Meanwhile, in Arizona, on the U.S. side of the border, much of the responsibility for managing the San Pedro basin has accrued to the Upper San Pedro Partnership (USPP). The USPP, over the past six or seven years has become the dominant force in the U.S. portion of the upper part of the watershed. With strong congressional and state support, this alliance of more than 20 agencies and NGOs has grown and gained respect. In the past year, the USPP was charged by the U.S. Congress with responsibility for assuring the sustainability of water in the basin.

Over the years, the Udall Center has been instrumental in the formation and maturation of the USPP and one of the project co-PIs, David Goodrich, is an influential member of the Partnership. In addition, we have co-authored several scientific and policy-oriented papers with members of the USPP. As a result, the research team has maintained excellent relations with the USPP and its leadership. The USPP has been highly receptive to attempts by the project, especially during the first year, to build binational, cross-border institutional relationships (as noted in the first interim report). But because of the past year's developments, we have decided to postpone further promotion of such linkages, which could be seen as unnecessarily intrusive. The chief constraint we have felt has been the relatively cautious approach taken by the USPP in regard to use and integration of climate forecasting tools in its water management planning activities.

In view of the past year's events, in September 2004 the project team met and decided to redirect some of its activities—in particular, those tasks that could not be undertaken in the present context (and we note here that we had already accomplished a great deal of fieldwork prior to the shift in relations, so that overall the impact of the political shift was muted somewhat). As a basis for the revision, the PI and co-PIs agreed, insofar as possible, to retain the overarching objectives of the project, namely to (1) assess products and tools, (2) attempt to bridge the communications gap, and (3) work to integrate science and policy.

The research team leadership resolved to reconfigure the project's activities as follows:

- Continue to convene, attend, and participate in relevant meetings on both sides of the border, while solidifying relationships with policymakers, managers, and other stakeholders.
- Identify appropriate, distinct, achievable research papers to be jointly-authored and submitted to peer-reviewed journals.
- Highlight the scientific aspects of the project, which seem to be more attractive to Mexican officials and others than the pursuit of policy-related objectives, most specifically by developing a prototype "Climate Outlook" package for the U.S.-Mexico border area modeled on the product for the southwestern United States developed by the Climate Assessment for the Southwest (CLIMAS) Project, and by collaborating on the use of decision-support tools.
- Address the communications gap via new curriculum development efforts.
- In all these undertakings, redouble our resolve to work closely with Mexican colleagues, especially in the academic sector, thus alleviating the perception of exogenousness while strengthening our credibility and building strong research alliances.

The team further concluded that the political developments that occasioned the changes, while unanticipated and problematic, also presented a good opportunity to analyze and write about those developments. The situation clearly offers particular insights into politics, water/climate decisionmaking, and agenda-setting in Mexico as well as more general lessons that could be of use elsewhere.

III. Accomplishments (Research Tasks, Preliminary Findings, Papers/Presentations)

This section is organized to reflect the revised structure as outlined in the preceding paragraph.

A. Research tasks

Solidifying relationships with policymakers, managers, and other stakeholders

During the reporting period, as shown in the list of meetings presented below, the project team interacted with numerous decisionmakers in the basin. Those consulted include elected officials such as the mayor of Cananea, Sonora, and Cochise County supervisors in Arizona; agency directors and planners such as COAPAES state water managers and town planners in Cananea and Hermosillo; officials of the Mexican national water commission in Hermosillo; and leaders of Arizona watershed organizations and state agencies. Additionally, team members met with colleagues interested in climate and water management from the University of Arizona, the University of Sonora, El Colegio de Sonora, and other scientists; educational directors and teachers; nongovernmental organizations; and attended and organized climate workshops with stakeholders. Key interactions included:

- June 2004. Project discussion with ISPE/CLIMAS on a Mexican perspective on water management in Sonora; issued a report on the situation of water utilities, watershed councils, decentralization and the politics of water in Sonora, Mexico with a focus on the San Pedro River

- September 2004. NOAA research team planning meeting
- November 2004-June 2005 monthly meetings with Upper San Pedro Partnership
- November 2004-June 2005 monthly teleconferences with Hydrology for the Environment Life and Policy (HELP) participants regarding exchange of watershed basin management strategies
- November 2004. SAHRA Transboundary Waters Conference, panel discussion on effectiveness of collaboration of scientists and stakeholders in basin management of climate and water
- January 2005. NOAA research team planning meeting
- January 2005 Prescott “Partnership” Workshop (facilitator)
- January 2005. Participation by all co-PIs in Sustainability Under Uncertainty in Arid and Semi-arid Ecosystems Workshop #1¹
- March 2005. Participation in EPA/SEMARNAT Border 2012 meeting in Tucson, at which announcement made by Mexican National Water Commission (CNA) about forming a technical committee (COTA) in the Mexican portion of the San Pedro Basin and presentation of the Good Neighbor Environmental Board regarding the need for data sharing in the borderlands
- March 2005. Climate vulnerability index planning workshop, Guayaquil, Ecuador (funded by UNESCO/HELP), including discussion of San Pedro basin issues
- April 2005. NOAA team planning meeting
- May 2005. Participation by all co-PIs in Sustainability Under Uncertainty in Arid and Semi-arid Ecosystems Workshop #2
- May 2005. Environmental Encuentro at Rosarito, B.C., facilitation of group discussions and presentation of NOAA project on use of climate information (poster)
- Nicolás Piñeda has interviewed CNA and Sonora state water management (COAPAES) officials in Hermosillo to determine problems in implementing new decentralized water policy and the use of climate data; CNA has expressed interest in establishing a regional climate center in Sonora (see IIIC below)
- CLIMAS manager and project co-PI Gregg Garfin has been meeting with Mexican colleagues to discuss design and preparation of potential products regarding northern Mexico (see IIIC below)

¹ NSF Grant No. SES-0345944, “Management of Ecosystems in the US Southwest and Related Areas of Northern Mexico in the Context of Complex Uncertainties.” Umbrella Initiative: Sustainability Under Uncertainty in Arid and Semiarid Environments (SUUASE). Funding for under this award is being used to hold a series of workshops aimed at assessing the potential for developing a binational center to conduct research on the sustainability of the US-Mexico borderlands in the context of complex biophysical and societal uncertainties (such as the political constraints described in the preceding section). The primary research focus is the greater Sonoran Ecosystem, which includes riparian areas such as the San Pedro River Basin. Two workshops have already been held; a third workshop, planned for early October, will be held in Hermosillo, Sonora, Mexico. While this project is independent of the one on which we are reporting, the two are closely connected insofar as they address the same geographic area and share many of the same objectives. To some degree, the SUUASE proposal was motivated by ISPE’s CLIMAS experience and by the present NOAA project.

Jointly-authored peer-reviewed research papers

1. “Collaborative Knowledge Production for Improved Water Management in the U.S.-Mexico Border Region” – Barbara Morehouse and Robert Varady

A precis has been developed for a paper to be published in a peer-reviewed journal. This paper will evaluate efforts to co-produce a shared knowledge base for implementing a binational watershed collaboration in the upper San Pedro River Basin. The insights gleaned from the analyses will be useful for identifying key barriers and opportunities that influence successful co-development of knowledge for border-area decisionmaking. The paper will propose recommendations for how the potential for success of such endeavors might be enhanced. It is anticipated that this paper will be submitted for peer review by Fall 2005.

2. “Decentralization of Urban Water Management and Climate Science Use for Sustainability Planning in Sonora” – Margaret Wilder and Carlos Rojas-Salazar

The paper will (1) analyze what climate and drought information and instruments are currently available and still needed by urban water managers in cities in the Upper San Pedro region and other regions of Sonora, and what they identify as critical needs; (2) analyze how climate information and climate science is being *utilized* by urban water managers; (3) identify drought or flood planning or mitigation measures being utilized; (4) identify what forms of public participation, if any, have been institutionalized in urban water planning. The research aims to determine whether more “democratic” institutions have led to greater demand for climate information/science or to improved sustainability in water planning decisions. Stakeholders included in the study are: water managers at the federal (C.N.A.), state (COAPAES and CEA), and municipal levels; NGOs (in particular, la Red Fronteriza Ecológica (the Border Environment Network); citizens involved in environmental education for water conservation; and academic water researchers.

Research Sites: Eight major Sonoran cities located throughout the state are included in the study: Nogales, Cananea, Naco, Hermosillo, Empalme/Guaymas, Obregon, Navojoa, and Alamos.

Methodology: Semi-structured, open-ended interviews have been conducted with approximately 50 stakeholders in the Sonoran study sites. To complete missing data, follow-up interviews have been conducted with some respondents. Fieldwork began in January 2004, and is anticipated for completion by approximately August 30, 2005.

Schedule: Complete fieldwork by end of August 2005; write article draft by December 15, 2005 and submit to refereed journal.

3. “Watershed Councils and Climate Science Use in Sustainability Planning in Sonora” – Margaret Wilder and Nicolás Piñeda

This study is closely-related to the decentralization study, and has essentially the same focus; however, the institutional analysis is focused on watershed councils rather than urban water management, in Sonora. Much of the fieldwork was carried out in tandem with the decentralization study, since many of the stakeholders especially in government positions overlap between the two. NOAA funding available through both the Udall Center and CLIMAS have sustained these two research projects.

There are three principal watershed councils in Sonora: the Upper Northwest (including the Upper San Pedro River); the Rio Yaqui/Matape; and the Rio Mayo. These were formed as a result of the 1992 national water law reforms and additional reforms adopted in April 2004.

Objectives: Analyze what climate information and science is currently available to watershed councils; analyze how existing climate information is being utilized by watershed councils (Have the watershed councils led to an increased demand for climate science and information, or led to more “sustainable” decisions?); and analyze the institutional features of watershed councils: areas of formal jurisdiction, content of agendas, structure and functioning of watershed councils.

Methodology: Semi-structured, open-ended interviews have been conducted with approximately 50 stakeholders in the Sonoran study sites. To complete missing data, follow-up interviews have been conducted with some respondents. Fieldwork began in January 2004, and fieldwork is anticipated for completion by approximately August 30, 2005.

Wilder has attended three watershed council meetings, and have scheduled attendance at more during the June-August 2005 period. (Note: Until recently, federal water officials in Hermosillo who supervise the watershed council effort have been reluctant to allow outside researchers to attend watershed council meetings; thus, our access has been quite limited. Nevertheless, recently we have begun to be advised of meetings with 1-2 weeks notice so we can attend, and we have been told we are welcome at meetings held over the coming summer months).

4. “Challenges to Implementing Transboundary Water Planning: A Political Ecology Perspective on Recent Policy Changes, Management Regimes, and Institutional Practices in U.S. and Mexico” – Nicolás Piñeda and Anne Browning-Aiken

Based partly on Piñeda’s 2005 interviews in Cananea with water managers and officials, this paper will report on research into funding and service issues. The authors employ a neoliberal theory approach (although this is really a critique of local application of neoliberal theory or philosophy) by contrasting policy with on-the-ground management practices and by discussing the challenges and potential political or institutional changes that could help implement climate and water policy locally. The paper is in progress and an early version was presented this spring at the 2005 annual conference of the Society for Applied Anthropology.

5. “Why Good Science Is Not Enough: Social and Institutional Dimensions of Ecosystem Sustainability in the Southwestern U.S. and Northwestern Mexico” – Margaret Wilder, Pablo Wong Gonzalez, Barbara Morehouse, Stephen Cornell, Nicolás Piñeda, Anne Browning-Aiken, and others

This paper is being prepared under the joint auspices of the NSF SUUASE grant.

Scientific cooperation

1. Development of a prototype “Climate Outlook” package for the U.S.-Mexico border area

Per plans articulated in the grant proposal, we have developed, over the past year, a draft prototype “climate outlook” package for the Mexico border area. The prototype is based on a monthly outlook for Arizona and New Mexico (available at <http://www.ispe.arizona.edu/climas/forecasts/swoutlook.html>) that has been produced by the NOAA/OGP-funded Climate Assessment for the Southwest (CLIMAS) Project for the last three years.

The value of a single source for climate information, such as the Southwest Climate Outlook, has been validated through research conducted by CLIMAS. Participants in the extended survey of the Arizona-New Mexico climate outlook package were found to place high value on region-specific commentary

included with the climate products, and to prefer “one-stop shopping” for information produced by different agencies.

The prototype border-area package brings together in one place information available from a variety of sources in the U.S. and Mexico on drought status, surface water status, recent temperature, and forecasts

Table of Contents, prototype “Climate Outlook” package for the U.S.-Mexico border area

Recent conditions

- Temperature (monthly and seasonal)
Sources: CNA (Mexico actual temperature), IRI/Columbia (U.S.-Mexico border departures from average temperature)
- Precipitation (monthly and seasonal)
Sources: CNA (Mexico actual precipitation), IRI/Columbia (U.S.-Mexico border departures from average precipitation)
- Drought Status (monthly)
Source: NCDC North American Drought Monitor
- Reservoirs and Streamflow
Source: Available on fishing conditions websites and IB&WC website; pending CNA approval for use of official data

Forecasts/outlooks

- Temperature (seasonal)
Source: IRI/Columbia (seasonal for North America)
- Precipitation
Sources: CNA (monthly); IRI/Columbia (seasonal for North America)
- El Niño
Source: IRI/Columbia

Forecast Verification (seasonal; contrast previous forecast products with recent conditions data)

- Temperature
Source: IRI/Columbia
- Precipitation
Source: IRI/Columbia

for the coming month and season (see attached table of contents and graphics). With further development, we anticipate that the package will also include value-added, region-specific information contributed by U.S. and Mexican scientists. Once the concept and prototype has been accepted and endorsed by Mexican scientists, managers, and policymakers for further development, we hope to conduct a user survey of the prototype by distributing copies of the outlook to selected border-area stakeholders for their evaluation and suggestions for revision and improvement. The ultimate goal is for production and dissemination of the outlook to be undertaken and implemented by the appropriate Mexican stakeholder entity. It is important to note, however, that further work on the border-area outlook is proceeding with extreme caution due to the political issues discussed above and the imperative need to secure approval from Mexican entities such as the CNA.

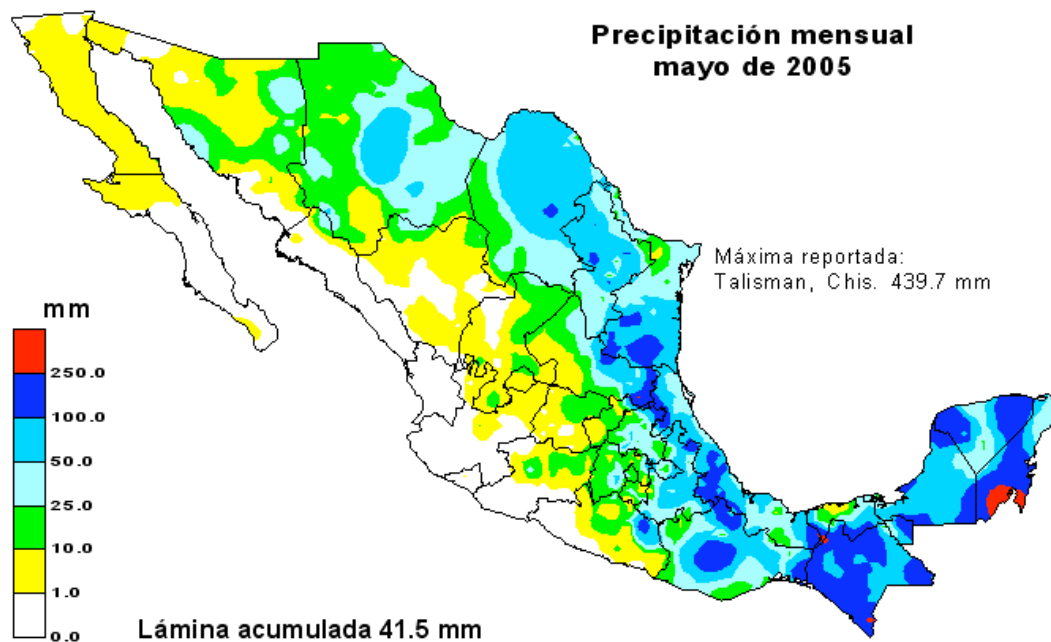


Figure 1. May 2005 Mexico precipitation (mm). Source: <http://smn.cna.gob.mx/productos/map-lluv/hmproduc.html>

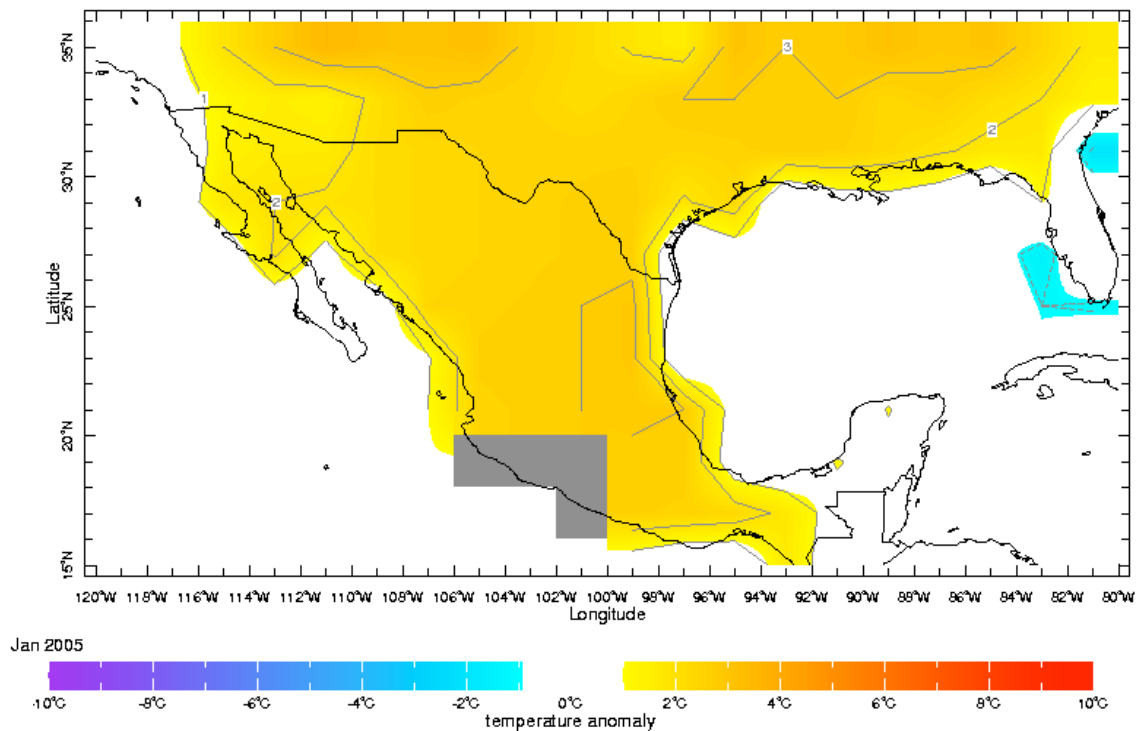


Figure 2. January 2005 U.S-Mexico Borderlands temperature departure from the 1971-2000 average (°C). Source: http://iridl.ldeo.columbia.edu/maproom/.Regional/.N_America/.Atm_Temp/Anomaly.html

Monitor de Sequía de América del Norte

Diciembre 2004

<http://www.ncdc.noaa.gov/nadm.html>

Liberado: Viernes, Enero 28, 2005

Analistas:

Canadá- Ted O'Brien

Dwayne Chobanik

México- Miguel Cortez

U.S.A.- Candace Tankersley *

Richard Heim

(* Responsable de la integración del mapa)

Intensidad de la Sequía:

D0 Anormalmente Seco

D1 Sequía - Moderada

D2 Sequía - Severa

D3 Sequía - Extrema

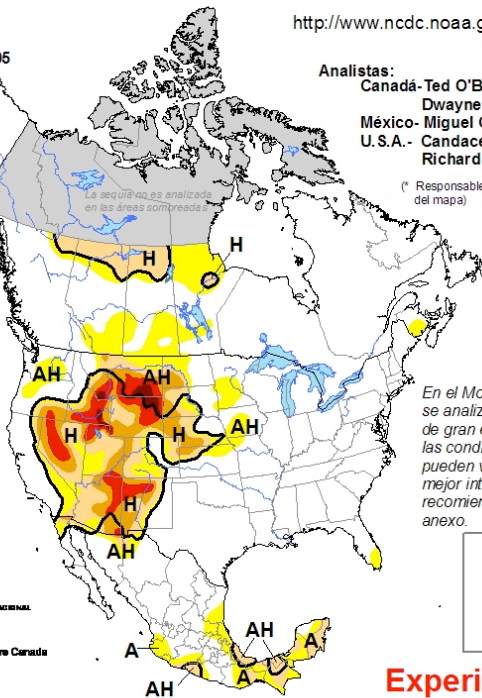
D4 Sequía - Excepcional

Delimita impactos dominantes

A = Agrícola

H = Hidrológica

(Sin A o H = Ambos impactos)



En el Monitor de Sequía se analizan condiciones de gran escala, por lo que las condiciones locales pueden variar. Para una mejor interpretación se recomienda ver el texto anexo.



Experimental

Figure 3. North American Drought Monitor, December 2004. Source: <http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/nadm-map.html>

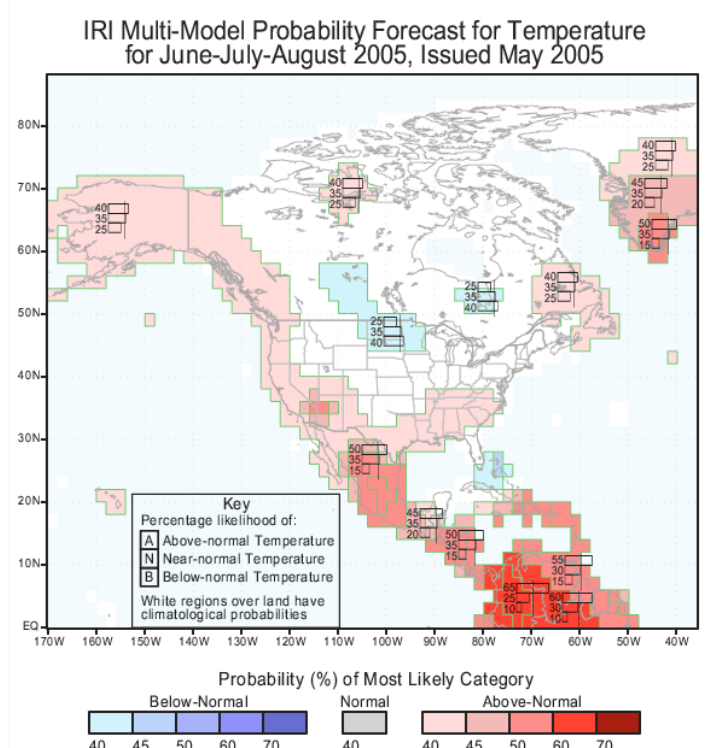


Figure 4. North American temperature forecast (three-category probabilities) for June-August 2005.

Source: http://iri.columbia.edu/climate/forecast/net_asmt/

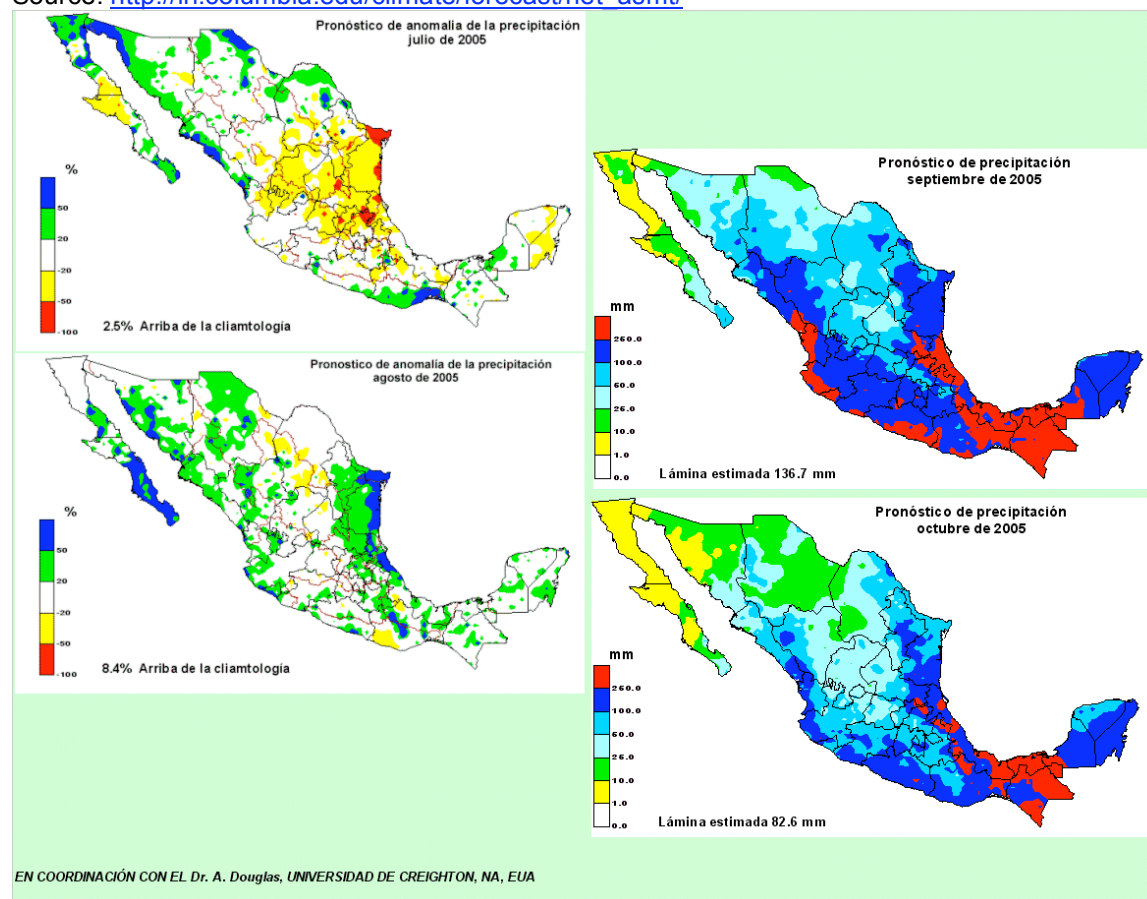


Figure 5. Mexico monthly precipitation forecasts for July-October, 2005. Source: From

<http://smn.cna.gob.mx/productos/map-lluv/p-clim02.gif>

2. Collaboration on the use of decision-support tools

As a consequence of a series of meetings with academic colleagues in Sonora, research team members came to appreciate the desire to develop a set of decision-support (DSS) tools that would be of mutual benefit. Beginning in the first project year, work was under way on such a tool being developed by UA engineering professor Kevin Lansey, under the auspices of the SAHRA project (see June 2004 progress report).

The most recent binational meeting took place on July 14-15, 2005. It was attended by José Maria Martínez (Universidad de Sonora), José Luís Moreno (Colegio de Sonora), Nicolás Piñeda (Colegio de Sonora), Manuel de Jesús Sortillón (Universidad de Sonora), Pablo Wong (Centro de Investigación en Alimentación y Desarrollo), Anne Browning-Aiken (Udall Center), Aleix Serrat (Udall Center and SAHRA—representing Prof. Lansey). The subject of the session was “Explorando Modelos de Ayuda a la Decisión para la Gestión del Agua en Arizona/Sonora: El ejemplo del Río San Pedro” (“Exploring Decision Support Models for Water Management in Arizona-Sonora: The Example of the San Pedro

River”). At El Colegio de Sonora, Hermosillo (organized by Anne Browning-Aiken and Aleix Serrat). The meeting was extremely interactive and positive and evinced serious interest on the part of the Mexican academics. Among future plans is another meeting in the fall to discuss the inclusion of climate components in the proposed DSS model.

Curriculum development

When the research team leadership met in September 2004 to consider ways to adapt to the changed political circumstances in Mexico, all agreed that we needed to strongly continue to try to bridge the communications gap. One of the best ways to achieve this, we felt, was to concentrate on environmental education for the population at large. Such an approach would take advantage of vigorous efforts already underway in this area and to modify these by introducing curricular materials on climate variability and change.

1. ECOSTART

Research team: *Anne Browning-Aiken, Denisse Fisher de León*

At the Udall Center, co-PI Anne Browning-Aiken has developed a program called ECOSTART, which is now in its second phase (ECOSTART II). With seed funding from EPA, SAHRA, the Morris K. Udall Foundation, and a number of local community associations, she and her team have been working with primary and secondary school teachers in Arizona and Sonora to introduce environmental topics into existing school curricula. Until recently, most of the subject matter pertained to water resources, especially to issues involving the San Pedro. Now, under the impetus of the present project, with the assistance and cooperation of CLIMAS manager and co-PI Gregg Garfin, and in collaboration with co-PI Margaret Wilder, ECOSTART has been introducing new items on climate, drought, flooding, and forecasting. The aim is to raise awareness among young persons, who will eventually be stakeholders.

2. K-12 Pilot Curriculum on Climate and Drought for Arizona-Sonora Region

In addition to the adapted ECOSTART tasks, Margaret Wilder has been working with two research assistants on specific climate and drought curricula for teachers and students in the Arizona-Sonora border region.

a. August-December 2004

Research Team: *Margaret Wilder, Julie Kentnor*

Goal: To develop a K-12 level pilot climate and drought curriculum for use in Tucson and Sonoran (Mexico) schools. The focus of the curriculum will be on the Arizona-Sonora region.

Research Objectives:

- Identify what water-, climate-, and drought-related curriculum materials currently exist both locally and via Internet sources, and identify significant gaps
- Within local Tucson school district curriculum, identify the most appropriate grades and areas to focus our efforts
- Review TUSD (local school district) curriculum requirements for what material should be covered, and ask for input on Sonoran requirements
- Brief sample of teachers to assess whether there is active interest in using such curricular materials
- Develop archive of currently available materials

Research Design:

Based on our analysis of information gathered during this phase, we developed the following target areas of focus:

- Focus on 4th and 6th grade curricula as most appropriate points-of-entry where this curriculum could be offered
- Due to the already full curriculum in TUSD with little space to spare for introducing new material, develop the pilot curriculum as short (1-3 days) lesson plans, rather than a full-blown curriculum
- There is no need to develop a curriculum on water, as “Project WET” already has an excellent curriculum for K-12 level on water
- Based on interactions with teachers via the Center for Latin American Studies (CLAS), K-12 teacher email listserv and follow up interactions, as well as feedback from a visiting Sonoran teachers’ group (CLAS), we believe there is sufficient teacher interest in the curriculum project to warrant moving forward

Research Activities:

- Meetings with approximately 20 curriculum experts (at UA and TUSD), drought and climate scientists, Tucson and Sonoran teachers, and professional associations (e.g., Arizona Geographic Alliance) to assess the current state of K-12 curricula in TUSD and to identify significant gaps
- Gather materials for archive on existing K-12 science curricula and requirements

b. January-May 2005

Research Team: *Margaret Wilder, Lisa Shipek*

Research Activities:

- Developed a short series of climate and drought draft lesson plans for 4th and 6th grade level science classes
- Met in February 2005 with visiting teachers at CLAS from Magdalena, Sonora to discuss climate and drought curriculum needs with them
- Sponsored a three-hour workshop in April 2005 attended by 12 TUSD teachers, and featuring UA Profs. Andrew Comrie and Tim Finan (M. Wilder was out of town presenting a paper), speaking on the physical and social science aspects of climate, drought, and vulnerability; Lisa Shipek then presented the draft lesson plans to the teachers, and the remainder of the workshop was spent on garnering teacher feedback and recommendations for improving the lesson plans

c. June-August 2005

Research Team: *Margaret Wilder, Lisa Shipek*

Planned Research Activities:

- Modify lesson plans based upon Tucson and Magdalena teachers’ input and recommendations for making them more useful and better adapted for classroom needs
- Once finalized, translate into Spanish and offer to give workshop to Magdalena teachers
- Relating to Sonora, meet with other faculty on campus (e.g., Diane Austin, Anne Browning-Aiken) who have established relationships with other Sonoran teachers and in Sonoran environmental education programs, to begin disseminating it further
- Meet with Udall Center, CLIMAS Project, and CLAS Web site staff to upload and feature the 4th and 6th Grade Climate and Drought Curriculum on their Web sites in Spanish and English

B. Preliminary findings

At the time of this report, the project is 22 months into its 36-month lifespan. In the first interim annual report, we reviewed some of the findings of the Mexican San Pedro Water and Climate Survey. We found appreciable vulnerability associated with lack of water infrastructure, water-quality concerns, and institutional issues—but other than susceptibility to drought and flood, little evidence for vulnerability to climate variability or change. It was clear, however, that the socioeconomic weaknesses tend to exacerbate existing vulnerability to climatic events. In addition, the survey revealed a number of insights into the most immediate concerns of and coping strategies employed by water users, managers, and decisionmakers. The observations below provide insight into the multiplicity of challenges faced by Mexican stakeholders in the Upper San Pedro River Basin, and into how climate information might be successfully integrated into decision making at scales ranging from households to the entire upper basin.

As the tabulation on pages 5 and 6 above shows, the project team has expended considerable effort solidifying relationships with stakeholders and academics in the region. We have believed from the start that trust can only be established via repeated personal contacts. In keeping with this notion, through numerous trips to the basin, a major effort has been expended on scientific collaboration through participation in regular project meetings and planning activities. Over the past year, much of this effort has been directed toward identifying the best strategies for achieving open communications with and trust of key Mexican constituencies. Both of these factors are essential to moving forward with regard to the central aim of the project, which is to improve the availability of useful, usable, and relevant climate information for people living on both sides of the border in the Upper San Pedro River Basin.

In spite of the issues confounding and complicating the team's work, the contacts we have nurtured have paid off by facilitating access to people, institutions, and information. And as we reported on page 4, due in part to persistence and largely the natural course of events, the political tensions that characterized much of the past year appear to be easing. This has allowed us to strengthen our workings with counterpart scientists and to discuss ways to develop and implement better climate diagnostic products such as the prototype "Outlook" instrument described on pages 8 to 12. Other preliminary findings drawn from this project and closely related undertakings are shown in the lists of publications and presentations that appear just below. Still more research and writing is underway and by the project's end, we will have amassed a sizable collection of peer-reviewed papers and other research products, as well as concrete achievements in the information-bridging realm.

Still other preliminary findings are:

- Such climate-related information as exists is almost exclusively short-term weather information, e.g., Weather Channel, NOAA/NASA, Federal Electric Commission, and other Web sites. Local Protección Civil's responsibility is to deal with potential crises due to weather. This is the niche the Outlook instrument seeks to fill.
- In Arizona and even more so in Mexico, all water information is highly political, especially among agricultural districts or facilities maintained by the government.
- There has been little if any interest in long-term climate programs, although the recent sustained drought has generated some interest in fire prevention in Alamos and some interest in climate impacts among nongovernmental workers in Nogales community-based activists.
- At this time, it is deemed advisable not to convene holding stakeholder workshops because of a split between governmental water/climate programs and grassroots organizers—which stakeholders are you going to invite? If you invite one, you insult the other.
- Asymmetrical differences in economy and political structure between the two neighboring countries have long complicated binational natural-resources management. But social and

political challenges to implementing water and environmental policy along the border may be further restricting opportunities for local or regional efforts to build the capacity of watershed councils for coordinated basin management. A series of binational meetings linking hydrological science and water-management technology and a Mexican community survey on water and climate demonstrates how science is subordinated to political will and examines how integrated binational and local water-resources planning is confounded by continuing centralized resource management in Mexico.

- The 2005 Water Management and Conservation Plan of the Upper San Pedro Partnership was published in March 2005 with the recognition that each town in the Arizona portion of the upper basin needs to include an account of their drought management efforts for their comprehensive general plan.
- The research team implemented a user evaluation of the Udall Center/SAHRA periodic publication, *San Pedro News & Comment (SPNC)*. In this survey, articles on climate variability and change were treated as a research tool and linked the *SPNC's* Web site was linked to SAHRA's much larger *Water Newswatch*.
- The team, led by co-PI Margaret Wilder and research assistant Lisa Shipek, has developed two educational curriculum units on climate change and variability for primary and secondary schools for use in the Mexico-US border communities. The group is working on a third curricular product that is expected to be ready by early fall 2005.
- With new funding from the Sierra Club, ECOSTART II is ready to begin integrating climate components into curricula for teachers in the San Pedro region.

C. Papers and presentations

Papers

- Browning-Aiken, A., A. Davis, F. Delgado, R. Carter, R. G. Varady, and B. Morehouse. Under review. Climate, water management, and policy in the San Pedro basin: results of a survey of Mexican stakeholders near the U.S.-Mexico border. Special issue of *Climatic Change*, ed. by P. Kabat.
- Browning-Aiken, A., R. G. Varady, D. Goodrich, W. J. Shuttleworth, H. Richter, and T. Sprouse. In press. The Upper San Pedro River HELP basin: an informal, binational approach to watershed management. In *Hydrology and Water Law: Bridging the Gap*, ed. by J. S. Wallace, P. Wouters, and S. Pazvakavamba. IWA Publishing.
- Browning-Aiken, A. 2004. Funds of knowledge and border crossings. In *Theorizing Practices: Tapping the Funds of Knowledge in Households*, eds. N. Gonzales, L. Moll, and C. Amani. Charlottesville, VA: Hampton Press.
- Browning-Aiken, A., H. Richter, D. Goodrich, B. Strain, and R. G. Varady. 2004. Upper San Pedro Basin: fostering collaborative binational watershed management. Special issue of *International Journal of Water Resources Development* 20(3), 353-367. ed. by L. Andersson and D. W. Moody.
- Browning-Aiken, A., R. G. Varady, and D. Moreno. 2004. Water-resources management in the San Pedro Basin: Building binational alliances. *Journal of the Southwest* 45, 4: 611-627.
- Goodrich, D. C., E. Z. Stakhiv, A. Browning-Aiken, K. Vache, J. R. Ortiz-Zayas, J. F. Blanco, F. N. Scatena, R. G. Varady, W. B. Bowden, W. Howland. In press. The HELP (Hydrology for Environment, Life and Policy) experience in North America. *Prdgs. of the EWRI (ASCE Environmental & Water Resources Institute) Watershed Mgt. Conference*. Williamsburg, VA.
- Liverman, D., R. G. Varady, O. Chávez, R. Sánchez, A. Browning-Aiken, and L. Stauber. 2004. Asuntos ambientales en la frontera México-Estados Unidos: Temas y acciones. In *Fronteras en América del Norte: Estudios multidisciplinarios*, ed. by A. Mercado Celis and E. Gutiérrez Romero. Mexico City: Universidad Nacional Autónoma de México, Centro de Investigaciones Sobre América del Norte. pp.

279-293.

- Richter, H., D. C. Goodrich, A. Browning-Aiken, R. G. Varady. In press. Riparian Area Conservation in a Semi-Arid Region: The San Pedro Example. Chapter 9 in *Integrating Science and Policy for Water Management*. Ed. By J. C. Stromberg and B. J. Tellman. Tucson: University of Arizona Press.
- Varady and Browning-Aiken. 2004-05. Contribution to Good Neighbor Environmental Board annual report, *Water Resources Management on the U.S.-Mexico Border*. Recognition of the impacts of climate variability and human vulnerability along the U.S.-Mexico border under section "Data, Drought and Floods."
- Varady, R. G., and A. Browning-Aiken. In press. The birth of a Mexican watershed council in the San Pedro basin in Sonora.. In *Planeación y Cooperación Transfronteriza en la Frontera México-Estados Unidos* (Transboundary Planning and Cooperation in the U.S.-Mexico Border Region), ed. by C. Fuentes and S. Peña.
- Varady, R. G., and B. J. Morehouse. 2004. *Cuanto cuesta?* Development and water in Ambos Nogales and the Upper San Pedro Basin. In *The Social Costs of Industrial Growth in Northern Mexico*, ed. by K. Kopinak.. La Jolla, CA: Center for U.S.-Mexican Studies, UCSD. pp. 205-248.
- Wilder, M., and P. Romero Lankao. 2006 (accepted). "Paradoxes of Decentralization: Water Reforms in Mexico." *World Development* (forthcoming).
- Wilder, M., and S. Whiteford. 2006. "Flowing Uphill Toward Water: Free Trade, Groundwater Management and the Ejido Sector in Mexico," in Laura Randall, ed., *Changing Structure of Mexico: Economic, Political and Social Prospects*, Armonk NY: M.E. Sharpe (accepted/forthcoming).
- Wilder, M. (submitted for review). "Water, Power and Social Transformation in Mexico," *Vertigo: La Revue de l'Environnement*.

Presentations

- Browning-Aiken, A., and N. Piñeda. 2005. Challenges to implementing Mexican water policy: a political ecology perspective on water resource collaboration, institutional bureaucracy, and local participation" presented at the Society for Applied Anthropology Conference, Santa Fe, NM. April.
- Browning-Aiken, A. 2005. Presentation on San Pedro basin at Workshop on Options for Use of Climate Vulnerability Index (CVI), sponsored by UNESCO International Hydrologic Programme (IHP)/HELP, Guayaquil, Ecuador, 21-23 March. Organized by Robert Varady.
- Browning-Aiken, A. 2005. "Climate variability and ecosystem impacts in the Southwest: proactive planning for natural resource conflicts," Impacts in Southwestern Forests and Woodlands, Sedona, AZ, 7-9 Feb.
- Browning-Aiken, A. 2004. HELP presentation on the San Pedro (U.S.-Mexico) and Lake Peipsi (Estonia/Russia) demonstrated how in different climatic, ecologic, and national regions, similar issues were raised, such as the importance of establishing trust, sharing information, and the difficulties posed by economic and political asymmetries, Second International Symposium on Transboundary Water Management, Tucson, AZ, 16-19 Nov.
- Browning-Aiken, A. 2004. Invited panelist and presenter on social issues regarding water and climate in the U.S.-Mexico San Pedro basin. Seminário Internacional Sobre Gestvo Social De Bacias Hidrográficas (International Seminar on Social Management of Watersheds), Urubici E Florianópolis, Santa Catarina, Brazil. 6-14 Aug.
- Browning-Aiken, A., R. G. Varady, B. Morehouse, and A. Davis. 2004. Pioneering a binational dialogue on water and climate: implementing institutional change. Presented at the AWRA & IWLRI International Specialty Conference on Good Water Governance for People and Nature, "What Roles for Law, Institutions, Science and Finance?" Dundee, Scotland. 30 Aug.
- Garfin, G., 2004. Borderlands Drought. Presentation (invited) to the Good Neighbor Environmental Board Meeting, Douglas, AZ, 17 Oct.

- Goodrich, D. C., E. Z. Stakhiv, A. Browning-Aiken, K. Vache, J. R. Ortiz-Zayas, J. F. Blanco, F. N. Scatena, R. G. Varady, W. B. Bowden, W. Howland. 2005. The HELP (Hydrology for Environment, Life and Policy) experience in North America. Presented at EWRI (ASCE Environmental and Water Resources Institute) Watershed Management Conference. Williamsburg, VA. 20 July.
- Rojas-Salazar, C., A. Serrat Capdevila. 2005. "Watershed Management in the Context of Climate Change: The Upper San Pedro Basin" (poster) presented at the Encuentro. 16-17 May.
- Varady, R. G., and B. Morehouse. 2004. *Cuanto Cuesta?* Environmental costs of development in the U.S.-Mexico border region. Presented at the XXV International Congress of LASA (Latin American Studies Association). Las Vegas, NV. 9 Oct.
- Wilder, M. 2005. "Water, Governance and the State: Narratives and Denouements of Decentralization in Mexico," Association of American Geographers Annual Meeting. 9 April.
- Wilder, M. 2005. Contributed to Andrea Ray's presentation at North American Monsoon Experiment (NAME) meeting, Mexico City. 10 Mar.
- Wilder, M. 2004. Invited plenary speaker, "Water, Power and Social Transformation in Mexico's Water Sector," "Water in the Americas" conference, Quebec, Canada. 10 Oct.
- Wilder, M. 2005. Invited plenary panel speaker, Urban Affairs Association Annual Meeting, Salt Lake City, Utah. 15 April.

IV. Relevance to the Field of Human-environment Interactions

The project is premised on the inseparability of the sociopolitical setting of the use of climate science from the application of that science. Because the two theaters in which this project is taking place—the U.S. and Mexican portions of the same river basin—are so radically different in nearly every way, they afford a fine opportunity to observe the critical human influences on what many scientists and managers once assumed were purely technical, and thus manifestly tractable problems.

The project's findings about resistance to the use of climate diagnostic products, for different reasons in the two countries, strongly confirm the importance of context. In Mexico, especially, we have witnessed first-hand the difficulties of navigating a well-established and change-averse decisionmaking system. The project is a firm reminder that understanding and analyzing the use of climate information varies in each society and to a large degree, in each local setting.

Appropriate information, tools, and instruments may be devised, but their introduction and adoption is far from assured by their utility or elegance. Instead, successful introduction of such products requires close familiarity with local issues, institutions, and actors, and in many cases membership or acceptance in the target society. Though inefficient, the only ways to overcome social, cultural, political, and in some cases legal barriers is through dedicated, time-consumptive, often frustrating relationship-building efforts.